An Innovative and Modular Approach for Deep Learning for Constellations of Smallsats

Completed Technology Project (2016 - 2018)

Project Introduction

The primary research and development goal of this research is to enable the usage of advanced machine learning algorithms, particularly deep learning, on embedded hardware systems such as satellites. This work would allow for powerful classification engines to be run on modest hardware, and lead the way for constellations of small satellites to perform near real-time triage of interesting events on the ground.

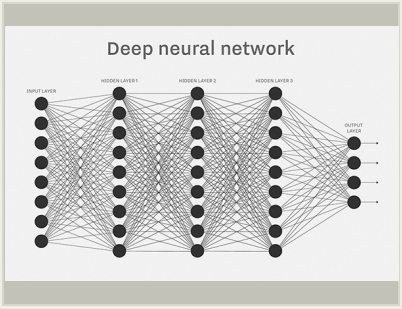
The primary long term objective of this project is have a machine learning framework that is geared towards being used on highly constrained hardware, and to show that framework being used in a simulated distributed spacecraft application. In the short term, the research will focus on one particular application of deep learning as a proof of concept. In order to do this, the first objective will be to curate a dataset that will be used as a training set for all permutations of the deep learning artificial neural network (ANN). The next objective will be to determine an optimal architecture for the ANN, and then to implement it in software for testing. Finally, once an optimal architecture is chosen, it will be mapped to hardware using energy efficient FPGAs.

The secondary objective is to use the previously developed ANN to do scene classification on real data, such as the AVIRIS, MODIS, and Hyperion multispectral data sets. The ANN will be trained to look for interesting scenes in a vast amount of data, and can be configured a number of different ways in order to look for fires, floods, algal blooms, and other situations.

The final milestone will be a full definition of a prototypical mission that can be used as an example of the proper use of the framework. This will include a generalization of the framework, which means that more cores will be added to accommodate a wider range of ANN architectures. Additionally, a mission will be described for using the framework to do near real-time detection of wildfires by analyzing multispectral data with the ANN developed in the previous milestone. This milestone is the final one for FY17 and will conclude in September.

Anticipated Benefits

This technology, when developed, will allow for advanced processing to be done in orbit that is, currently only able to be done on high powered terrestial computers.



Deep neural network

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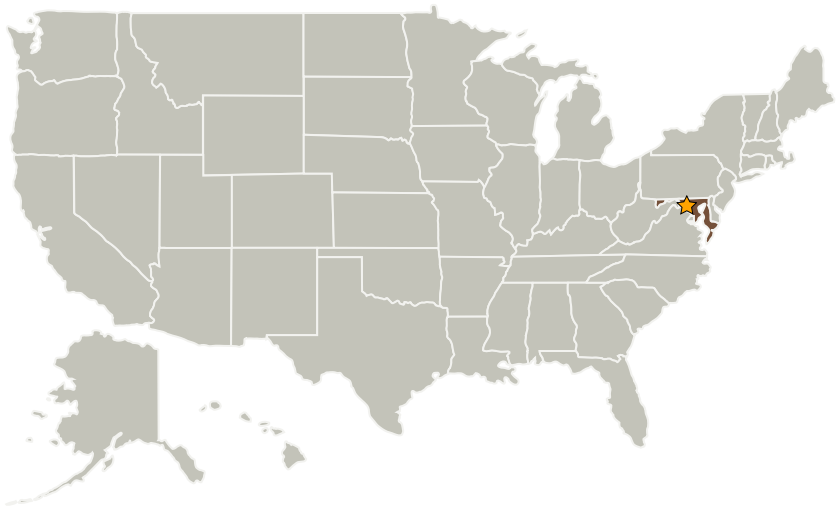
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

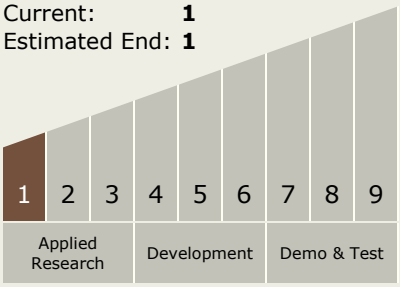
Jacqueline J Le Moigne-stewart
Michael A Johnson

Principal Investigator:

James P Mackinnon

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **1**



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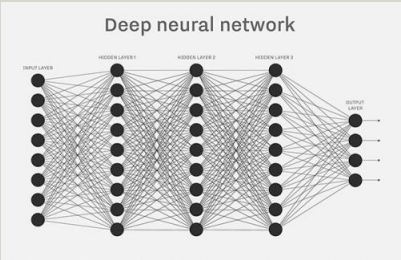
Images



Deep Neural Networks
Deep neural network
(https://techport.nasa.gov/image/26331)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.4 Information Processing
    - TX11.4.2 Intelligent Data Understanding

Target Destinations

Foundational Knowledge, Earth